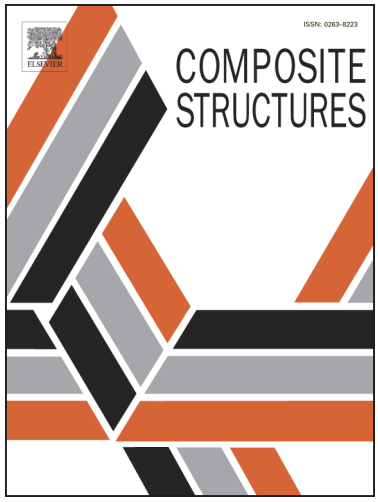

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PII: S0263-8223(15)01062-4
DOI: http://dx.doi.org/10.1016/j.compstruct.2015.11.059
Reference: COST 7014

To appear in: *Composite Structures*

Please cite this article as: Kiani, K., Free dynamic analysis of functionally graded tapered nanorods via a newly developed nonlocal surface energy-based integro-differential model, *Composite Structures* (2015), doi: http://dx.doi.org/10.1016/j.compstruct.2015.11.059

Free dynamic analysis of functionally graded tapered nanorods via a newly developed nonlocal surface energy-based integro-differential model

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Abstract

The nonlocality effect based on appropriate kernel functions plays an important role in mechanical behavior of nanostructures. This phenomenon is not limited to the bulk, but also includes the surface layer. However, these important issues have not been properly paid attention to in the previously developed continuum-based models. Using a novel nonlocal integro-differential model accounting for the surface energy effect, free longitudinal vibration of functionally graded tapered nanorods embedded in an elastic matrix is investigated. The material properties of both the bulk and the surface layer vary along the nanorod's length based on a power-law relation. By considering the nonlocal integro-differential constitutive relations for the bulk as well as the surface layer, the equations of motion of the elastically supported nanostructure are obtained and analyzed via reproducing kernel particle method (RKPM). In particular cases, modal analysis is also implemented and the obtained results by the RKPM are successfully verified with those of the modal analysis approach. The roles of the surface energy, small-scale parameter, stiffness of the matrix and that of the supports, nanorod's diameter, power-law index, and the nonlocal kernel function on the natural frequencies are explained in some detail.

Keywords: Tapered nanorods; Axial vibration; Functionally graded materials; Nonlocal integro-differential-based modeling; Reproducing kernel particle method (RKPM).

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